



# General Assembly

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## Committee on the Peaceful Uses of Outer Space

### Activities carried out in 2018 in the framework of the workplan of the International Committee on Global Navigation Satellite Systems

#### Report of the Secretariat

#### I. Introduction

1. The International Committee on Global Navigation Satellite Systems (ICG) was established under the auspices of the United Nations in 2005. In order to provide civil services related to global navigation satellite systems (GNSS) that benefit users worldwide, ICG continues to pursue the establishment of a GNSS system of systems. The priorities of ICG include continued focus on spectrum protection, interference detection and mitigation, and transparent provision on interoperable civil services.
2. ICG meets annually to review and discuss developments in the field of GNSS and to allow ICG members, associate members and observers to address recent developments in their organizations and associations with regard to GNSS services and applications. The membership of ICG consists of 10 member States, the European Union and 21 intergovernmental and non-governmental organizations. The Office for Outer Space Affairs of the Secretariat has been an associate member of ICG since its establishment and serves as the executive secretariat of ICG and its Providers' Forum. The Office is therefore responsible for preparation activities for each annual meeting of ICG in cooperation with the host country.
3. The Office for Outer Space Affairs coordinates the planning meetings of ICG and its Providers' Forum, as well as the intersessional meetings of the ICG working groups held in conjunction with sessions of the Committee on the Peaceful Uses of Outer Space and its subsidiary bodies. The Office also coordinates the implementation of the ICG programme on GNSS applications.
4. The Office is actively involved in all the ICG working groups associated with the ICG workplan and leads its working group on information dissemination and capacity-building (Working Group C).
5. The thirteenth meeting of ICG was held in Xi'an, China, from 5 to 9 November 2018. The Providers' Forum held its twenty-first meeting in conjunction with that ICG meeting, on 4 and 8 November 2018 (A/AC.105/1191).
6. The present report contains a description of the activities undertaken or supported by the Office for Outer Space Affairs during 2018 and the main results achieved. Detailed



information on the activities, as well as educational resources, is available on the ICG information portal ([www.unoosa.org/oosa/en/SAP/gnss/icg.html](http://www.unoosa.org/oosa/en/SAP/gnss/icg.html)).

## **II. Activities of the International Committee on Global Navigation Satellite Systems carried out in 2018**

7. Pursuant to the ICG workplan for 2018 and the recommendations contained therein, the Office for Outer Space Affairs, in partnership with members, associate members and observers of ICG and international entities, focused on: (a) disseminating information through the information centres hosted by the regional centres for space science and technology education, affiliated to the United Nations; (b) promoting the use of GNSS as tools for scientific applications; and (c) building the capacity of developing countries in using GNSS technology for sustainable development.

### **A. Information dissemination through the information centres hosted by the regional centres for space science and technology education, affiliated to the United Nations**

8. The ICG information centres are hosted by the regional centres for space science and technology education, affiliated to the United Nations. The regional centres are in India and China for Asia and the Pacific, in Morocco and Nigeria for Africa, in Brazil and Mexico for Latin America and the Caribbean and in Jordan for West Asia. The centres focused on satellite navigation programmes, through the nine-month postgraduate courses on GNSS, and regional activities to facilitate the development of GNSS-related applications.

9. The ICG publication entitled *The Interoperable Global Navigation Satellite Systems Space Service Volume* was made available to the regional centres, both for training purposes and to disseminate information on multi-GNSS space service volume. The information in the publication is a single resource with a concise overview on the characteristics of every GNSS provider as their contribution to the interoperable GNSS space service volume. GNSS usage in space service volume will lead to fully autonomous, on-demand navigation for GNSS users. For example, weather satellites employing GNSS signals in space service volume will enhance weather prediction and public-safety situational awareness of fast-moving events, including hurricanes, flash floods, severe storms, tornadoes and wildfires.

### **B. Promoting the use of global navigation satellite system technologies as tools for scientific applications**

#### **1. Space weather effects on global navigation satellite systems**

10. Space weather is the variation in Sun energy emissions, solar wind, magnetosphere, ionosphere and thermosphere, which can influence the performance and reliability of a variety of space-borne and ground-based technological systems. Space weather is consequently recognized as the cause of significant errors experienced by GNSS, satellite-based augmentation systems and their users.

11. Signals from GNSS or satellite-based augmentation systems are propagated from a satellite to the user receiver. In the process, the signals pass through the ionosphere, where they are subject to the damaging effects of space weather. Under such conditions, pseudorange errors and signal scintillations at the level of the user receiver are present. The effects are critical at low latitudes.

12. A workshop on space weather effects on GNSS operations at low latitudes was held in Trieste, Italy, from 23 April to 4 May 2018, in cooperation with the Abdus Salam International Centre for Theoretical Physics (ICTP), the Institute for Scientific

Research (ISR) of Boston College and ICG. The purpose of the workshop was to provide theoretical and practical training on the physics of space weather and its main effects on GNSS operations, with an emphasis on the low-latitude ionospheric processes related to space weather.

13. The workshop was the tenth in a series of activities in the field carried out since 2009, both in Trieste and in Africa, by ICTP in partnership with ISR of Boston College, ICG and the Institute of Navigation.

14. During the first day of the workshop, a presentation was made on the impact of these training activities on capacity-building in the field in Africa and in general in developing countries. Experts from Nigeria, Côte d'Ivoire, Ethiopia, Argentina and Malaysia gave presentations on research projects and academic achievements in their countries that were made possible as a result of the joint training activities. Detailed information about the workshop is available on the website of ICTP.

15. A total of 65 experts from 29 countries participated in the workshop. Funds provided by the United States of America and the European Commission through ICG were used to defray the costs of air travel for 18 experts from Argentina, Chile, Côte d'Ivoire, Ethiopia, Fiji, Ghana, India, Indonesia, Kenya, Malaysia, Nepal, Nigeria, Pakistan, Senegal, Thailand and Uganda.

16. The International Space Weather Initiative school on space weather and GNSS was held in Baku from 8 to 12 October 2018, with a view to promoting the topics of space weather and GNSS among scientists, engineers and doctoral students in solar physics, space science and engineering. The school was organized by the Science Development Foundation under the President of the Republic of Azerbaijan, the Shamakhy Astrophysical Observatory of the Azerbaijan National Academy of Sciences, ISR of Boston College, the Scientific Committee on Solar-Terrestrial Physics and ICG. Hosted by the Science Development Foundation and the Shamakhy Astrophysical Observatory, the school was a follow-up activity to the United Nations/United States Workshop on the International Space Weather Initiative, held in Boston, United States, in 2017 (A/AC.105/1160).

17. The school was an excellent learning and enrichment opportunity for young scientists and graduate students from countries in Africa, Asia and Eastern Europe. Upon completion, participants were able to understand basic concepts of space, solar and ionospheric physics, as well as physical principles that apply therein and the methods by which scientific research was conducted. During the school, technical tours were organized to Azercosmos Open Joint Stock Company, the Shamakhy Astrophysical Observatory and the National Aviation Academy. Participants also attended a fulldome show, entitled "The Sun, our living star", at the Tusi-Bohm Planetarium. Detailed information about the school is available at the Science Development Foundation website.

18. A total of 53 experts from 24 countries participated in the school. Funds provided by the United States, the European Commission and the Scientific Committee on Solar-Terrestrial Physics were used to defray the costs of air travel for 21 experts from 15 countries: Bangladesh, Bosnia and Herzegovina, Croatia, Egypt, France, India, Iran (Islamic Republic of), Kazakhstan, Mongolia, Morocco, Nepal, Turkey, Ukraine, Uzbekistan and Viet Nam.

19. Positioning services are becoming an essential part of daily life. Reliability is essential for positioning and navigation applications such as critical services for public safety and consumer and leisure products. However, GNSS technology is highly vulnerable to a range of threats, both artificial and natural.

20. An expert seminar on natural and artificial threats to GNSS was held at the Politecnico di Torino in Turin, Italy, from 7 to 9 May 2018. The seminar was organized by the Politecnico di Torino in cooperation with the Istituto Superiore Mario Boella and ICG. The seminar addressed recent challenges in modelling the natural and artificial phenomena, as well as the latest solutions proposed as

countermeasures. It was noted that GNSS was vulnerable to interferences; at the same time, GNSS was a resource for studying interference features.

21. A total of 70 experts from 12 countries participated in the seminar. Funds provided by the European Commission through ICG were used to defray the costs of air travel for three experts from India and the Sudan.

## **2. Reference frames and timing**

22. GNSS can provide accuracy to the level of a centimetre with a low-cost receiver, if an error correction technique is used. Therefore, availability of low-cost and high-accuracy receivers will eventually increase GNSS-related applications and the market for such applications. To keep pace with such new applications and developments, it is necessary to develop knowledge and technical skills in GNSS technologies and applications.

23. A training course on GNSS was held in Bangkok from 23 to 26 January 2018 to raise awareness on GNSS and its applications in the Asia and the Pacific region. The course was organized by the Geoinformatics Centre of the Asian Institute of Technology and the Centre for Spatial Information Science at the University of Tokyo, with the support of ICG. The course's objectives were to introduce GNSS; provide an overview of signal processing in receiver and receiver performances; introduce precise point positioning, RTKLIB (an open-source GNSS-processing software) and SW Maps software; and conduct a field survey, using a low-cost receiver for high-accuracy positioning. During the training course, the participants learned various methods of signal processing, including precise point positioning and post-processing or real-time kinematics for high-accuracy using data from the survey and low-cost GNSS receivers.

24. A total of 61 experts from 15 countries participated in the training course. Funds provided by the United States through ICG were used to defray the costs of air travel for 16 experts from Bhutan, India, Indonesia, Malaysia, Maldives, Mongolia, Nepal, the Philippines, Tajikistan and Viet Nam.

25. In recognition of a number of ongoing projects and initiatives to establish regional reference frame networks that meet the growing needs of industries, science programmes and the members of the general public that are using precise GNSS-positioning applications, the Commission on Positioning and Measurement (Commission 5) of the International Federation of Surveyors and the International Association of Geodesy, in cooperation with ICG, organized a series of the technical seminars to share knowledge and to raise awareness on the benefits to be derived from the utilization of geospatial information for sustainable development.

26. A technical seminar on reference frame in practice was held in Istanbul, Turkey, on 4 and 5 May 2018. It was organized and sponsored by the Chamber of Survey and Cadastre Engineers of Turkey, Leica Geosystems and Trimble Inc. The focus of the seminar was reference frames in general, kinematics and dynamic datums that reflect geodetic priorities for all regions that are vulnerable to earthquakes. Participants in the seminar represented countries where there was a strong need to model deformation to be able to maintain their accurate geospatial reference frames. A technical tour was organized to Kocaeli Municipality, along the North Anatolian Fault Zone, which was the site of the earthquake with a magnitude of 7.4 in August 1999. Detailed information about the seminar is available on the website of the International Federation of Surveyors.

27. A total of 36 experts from 18 countries participated in the seminar. Funds provided by the United States through ICG were used to defray the costs of air travel for two experts from Nepal and Mongolia.

28. The thirteenth annual scientific workshop of AfricaArray was held from 24 to 27 June 2018 at the University of the Witwatersrand in Johannesburg, South Africa. The workshop brought together researchers who utilize seismic and Global Positioning System data to share their research results and collaborate on new and

ongoing projects. The presentations covered the following four topics: the structure, tectonics and resources of Africa; geodesy and space science; seismic monitoring and hazard assessment; and mining-related seismicity. A one-day training course on using and maintaining the Global Positioning System and seismic equipment in the AfricaArray network observatories was conducted for the workshop participants. Detailed information about the workshop is available at the AfricaArray website.

29. Funds provided by the United States through ICG were used to defray the costs of air travel for 13 experts from Cameroon, the Democratic Republic of the Congo, Egypt, Ghana, Malawi, Morocco, Nigeria and Uganda.

### **C. Building the capacity of developing countries in using global navigation satellite system technology for sustainable development**

#### **Regional workshop on global navigation satellite systems applications**

30. The United Nations/Argentina workshop on the applications of global navigation satellite systems was organized by the Office for Outer Space Affairs in cooperation with the National Commission for Space Activities (CONAE) of Argentina. The workshop was held at the Teófilo Tabanera Space Centre, a facility of CONAE, in Falda del Carmen, Argentina, from 19 to 23 March 2018. It was co-sponsored by the European Commission and the United States through ICG. The European Space Agency also co-sponsored the workshop (A/AC.105/1205).

31. A one-and-a-half-day seminar on GNSS spectrum protection and interference detection and mitigation, organized by the ICG working group on systems, signals and services (Working Group S), was held during the seminar. The purpose of the seminar was to highlight the importance of GNSS spectrum protection at the national level and explain how to reap the benefits of GNSS. The seminar contained presentations that demonstrated GNSS jamming and spoofing.

32. The recommendations and observations put forward by the participants in the workshop provided guidance on how institutions could work together through regional partnerships. The Office for Outer Space Affairs should provide support for the consolidation of the partnerships formed at the workshop. Those partnerships would result in the sharing and transfer of knowledge and the development of joint activities and project proposals.

33. The presentations made at the workshop, abstracts of the papers given, the workshop programme and background materials are available on the website of the Office for Outer Space Affairs ([www.unoosa.org](http://www.unoosa.org)).

## **III. Technical advisory services**

34. In order to inform a wide audience about the current status and future role of ICG in a multi-GNSS arena, and to receive feedback from the entire GNSS community, the Office for Outer Space Affairs participated in and contributed to the following international conferences and symposiums:

(a) Munich Satellite Navigation Summit 2018, held in Munich, Germany, from 5 to 7 March 2018;

(b) Twelfth International Satellite Navigation Forum, held in Moscow on 24 and 25 April 2018;

(c) Second International Union of Radio Science Atlantic Radio Science Conference, held in Gran Canaria, Spain, from 28 May to 1 June 2018;

(d) Ninth China Satellite Navigation Conference, held in Harbin, China, from 23 to 25 May 2018;

(e) Fifty-eighth Meeting of the Civil Global Positioning System Service Interface Committee at the Institute of Navigation GNSS+2018 Conference, held in Miami, United States, on 24 and 25 September 2018;

(f) Twenty-second Positioning, Navigation and Timing Advisory Board Meeting, held in Redondo Beach, United States, from 4 to 6 December 2018.

35. The Office participated in and contributed to the United Nations/Germany high-level forum on the way forward after UNISPACE+50 and on Space2030, held in Bonn, Germany, from 13 to 16 November 2018. The work related to space weather of the ICG working groups was presented. It was outlined that ICG activities had attracted growing interest in the acceptance and use of GNSS in academic and research programmes on space environment studies and applications in developing countries.

36. The tenth Multi-GNSS Asia Conference was held in Melbourne, Australia, from 23 to 25 October 2018. Funds provided by the United States and the European Commission through ICG were used to defray the costs of air travel for six experts from India, the Philippines, Thailand and Viet Nam. Those participants presented their research work in the field of GNSS.

37. The Office organized two preparatory meetings for the thirteenth meeting of ICG. Chaired by China, the meetings were held in Vienna on 5 February, on the margins of the fifty-fifth session of the Scientific and Technical Subcommittee of the Committee, and 19 June 2018, on the margins of the sixty-first session of the Committee.

38. The Office also organized the twentieth meeting of the Providers' Forum. It was held in Vienna on 18 June 2018 and co-chaired by China and Japan. The meeting focused on issues related to open-service information dissemination, service performance monitoring, spectrum protection, and interference detection and mitigation. An update on space service volume was provided by the ICG working group on enhancement of GNSS performance, new services and capabilities (Working Group B). A summary of the activities undertaken by the ICG information centres was provided by the ICG executive secretariat. A report on a multi-GNSS demonstration project carried out in Asia and Oceania was presented.

39. The Office organized intersessional meetings of ICG working groups. Those meetings formed the basis for the views and recommendations on spectrum protection, open service performance, the monitoring of open services, the review of integrity concepts of the positions of existing users and further action. The following intersessional meetings and workshops were held in 2018:

(a) The seventh GNSS interference detection and mitigation workshop was held in conjunction with the twelfth annual Baska GNSS conference in Baska, Croatia, from 6 to 9 May 2018, under the auspices of the subgroup on compatibility and spectrum protection of Working Group S. At the workshop participants continued to investigate methods of implementing interference detection and mitigation capabilities through permanent network-based solutions and through crowdsourcing techniques;

(b) An intersessional meeting of the interoperability and service provision subgroup of Working Group S was held in Vienna on 19 June 2018. The progress made by the International Telecommunication Union in encouraging national regulators to use relevant protection criteria for GNSS was assessed. The compatibility of search and rescue downlinks broadcast by GNSS in the L-band was added to the scope of the subgroup's work;

(c) The intersessional meeting of Working Group S was held in Noordwijk, the Netherlands, on 16 and 17 July 2018, to discuss the following topics: standards for interference detection and mitigation, signal compatibility and spectrum protection, and interoperability-related issues, such as timing, open-service standards, and multi-GNSS monitoring and assessment;

(d) A joint timing workshop of Working Group S and the working group on reference frames, timing and applications (Working Group D) was held in Vienna on 20 June 2018. The workshop deliberations resulted in immediate actions related to assessing two concepts proposed by the European Space Agency and consideration of future actions;

(e) The interim meeting of Working Group B was held in Vienna on 21 and 22 June 2018. The meeting reviewed the progress in the implementation of the recommendations made at the twelfth meeting of ICG, in 2017, and discussed additional recommendations for further consideration by ICG;

(f) An intersessional meeting of Working Group D was held, in conjunction with the Multi-GNSS Asia Conference, in Melbourne on 24 and 25 October, to discuss interoperability of GNSS precise positioning services.

#### **IV. Voluntary contributions**

40. In 2018, ICG activities were successfully implemented thanks to support and voluntary contributions, financial and in-kind, provided by member States:

(a) The Government of the United States provided \$200,000 to support capacity-building and technical advisory services, and arranged for experts to make technical presentations and participate in discussions during activities described in the present report;

(b) The European Commission provided 100,000 euros to support capacity-building and technical advisory services, and arranged for experts to make technical presentations and participate in discussions as part of activities described in the present report;

(c) The Government of China provided financial support for one staff member of the Office for Outer Space Affairs to participate in and contribute to the thirteenth meeting of ICG and its planning meetings;

(d) The Government of the Russian Federation provided financial support for experts to make technical presentations and participate in discussions as part of activities described in the present report.

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